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The slowness of surface erosion as indicated by these observations suggests that the theory of the development of "fault-sags" by erosion subsequent to the faulting may yet be found correct in some instances. Sufficient underground water may seldom be present to facilitate such action. The heaviest rainfall for a single month recorded at San Francisco is 24.36 inches. As this indicates a possibility of forty inches in a single month with the heavier rainfall of the fault zone, the greatest rapidity of erosion and the best opportunity for the development of an erosional fault-sag may not have occurred as yet. Any conclusion as to the erosional origin of fault-sags along the rift will have to be deferred until the observations have been carried on for a much longer period and until several years of excessive rainfall have occurred.

ABSTRACTS OF PAPERS READ AT THE JOINT MEETING OF THE A. G. S. AND THE A. A. G. IN NEW YORK, APRIL 3 AND 4, 1914

THE PLATFORMS OF BARRIER CORAL REEFS. By THOMAS WAYLAND VAUGHAN

There are three kinds of coral reefs, *viz.:*

1. Fringing or shore reefs which occur along the strand line.
2. Barrier reefs which occur at variable distances off shore and have lagoons from one or two to as much as thirty or even forty fathoms in depth between them and the strand line.
3. Atolls, which are ring-like and inclose lagoons above whose surface no land masses of importance protrude.

As the relations of barrier reefs and atolls to the platforms on which they stand constitute, in the opinion of geologists, the essential part of the theory of the development of Recent reefs, the warfare of coral reef theory has been waged over the interpretation of these relations, which are the conditions of changing or changed position of the strand line and the part played by reef-forming organisms as constructional agents. The special object of the paper was to point out the relations of barrier coral reefs to the last dominant change in the position of the strand line and to indicate the part the organisms forming Recent barrier reefs have played in building the reef platforms.

The introductory remarks were followed by a résumé of the principal hypotheses and theories advanced in explanation of barrier reefs and atolls. Those of Darwin, Dana, Semper, Murray, Admiral Sir W. J. L. Wharton, Alexander Agassiz, C. E. Andrews, Stanley Gardiner, Hedley and Griffith Taylor, Daly, and Wood-Jones were briefly reviewed. It was pointed out that, according to Darwin and Dana, barrier reefs and atolls margin platforms built during subsidence by agencies dependent upon the presence of reefs, while the other hypotheses advance different explanations.

The criteria for determining the direction and amount of change in position of strand line, whether by positive or negative movement, were briefly enumerated. With regard to criteria for estimating the constructional work of reef-forming organisms is was said that if corals and the associated organisms, which form the material composing what are designated coral reefs, have built the platform, the geographic limits of the reef platform and the reef-forming organisms should be coincident; and that, if the platform owes its origin to agencies other than those of reef-forming organisms—the reefs being merely superimposed upon it—its extent should be beyond the limits of such organisms and independent of their presence.

The recent literature in which physiographic criteria have been applied to the eludication of the coral reef problem was briefly reviewed. Attention was especially directed to the work of Alexander Agassiz, Verrill, and others in the Bermudas; Alexander Agassiz and others in the Bahamas; Hayes, Vaughan, and Spencer in Cuba; Branner in Brazil; Sanford, Matson, and Vaughan in Florida; C. E. Andrews, Hedley and Griffith Taylor, and T. W. Edgeworth David in Australia; Wood-Jones in the Cocos-Keeling group; P. Marshall in the Society and Cook islands; and C. Elschner in Nauru and the Paumotus. The enumeration showed that both American and Australasian geologists, each group working in the region in which it was located, have been persistently applying physiographic criteria to the study of the coral reef problem for the past thirteen or fourteen years.

The results of the author's recent expedition to several smaller West Indian islands, largely for the purpose of studying the changes in strand line antecedent to the development of the living barrier reefs, were presented. It was shown that the shore line of Antigua is deeply indented by numerous bays and harbors, as St. Johns, Five Islands, and Falmouth harbors, and Willoughby, Nonsuch, and Belfast bays. The absence of terraces and elevated wave-cut cliffs was mentioned, and it was stated that in St. Johns Harbor at a depth of about twenty feet below sea level a four-foot bed of peat, which according to Mr. C. A. Davis is not composed of marine plants, adds confirmation to the inference that the last important movement of sea level was positive. Stable conditions for some time is shown by the alluvial fillings at the heads of reentrants and along streamways, and by high wave-cut cliffs. The island of Barbuda, which occupies the northern part of the shallow plateau on the southern part of which is Antigua, is separated from the latter island by water eighteen fathoms or less in depth. In Barbuda fresh-water springs which emerge below sea level have been observed by Mr. H. A. Tempany, and the similarity of the land mollusca of Antigua and Barbuda supports the inference that these islands were part of one land mass in Pleistocene time and have been severed by positive movement of sea level. Barrier reefs occur as disconnected banks on the platform near both Antigua and Barbuda. It is evident that this platform has been submerged and that its existence is independent of the reefs which grow upon it in certain favorable localities.

The islands St. Bartholomew, St. Martin and Anguilla, which rise above the surface of the St. Martin Plateau, are separated by water ranging from fourteen to sixteen fathoms in depth, while there is an increase in declivity near the edge of the platform at depths between thirty and forty fathoms. That the last important change of sea level was by positive movement is evident from the indented character of the shore line in St. Bartholomew, St. Martin and Anguilla; and in Anguilla additional evidence is afforded by the underground communication between the sea and inclosed basins in the limestone. Stable condition of the shore line for a considerable period is attested by wave-cut cliffs, the development of the beaches, and the alluvial fillings at the heads of reentrants in the land mass, and, in St. Martin, by the presence of unterraced flood plains along the streamways. Barrier reefs occur in places off these three islands but are disconnected and occupy a very small proportion of the surface of the platform. It is evident that these reefs are merely superimposed on an antecedent platform brought into its present relation to sea level by submergence.

The well-developed barrier reefs off both the north and south coasts of St. Croix Island occupy portions of the surface of a platform which, as shown by the indented, ragged coastline and the depth of water on the platform, has been submerged. The platform above the surface of which the Virgin Islands rise, the nature of their coast line, and the coral reefs of the Virgin Bank, were briefly described. The maximum depth of water between the islands is about seventeen fathoms. The coastal phenomena, such as reentrants into the land mass, alluvial fillings at their heads, unterraced alluvial bottoms along streamways, and wave-cut cliffs on the unterraced promontories, were mentioned, especially for the island of St. Thomas, which was personally examined by the author. The conditions under which the coral reefs of the Virgin Bank and eastern Porto Rico have been developed are clear, that is, they also are superimposed on a depressed platform, a very small portion of the surface of which is covered by them.

These relations were shown to be similar to those already known to prevail in Florida, Andros Island, Bahamas, and Cuba, where the living barrier reefs stand upon depressed platforms which are independent of the reefs as they are continuous irrespective of the geographic limits of the reefs.

The barrier reefs of Honduras, Nicaragua, and Brazil were next briefly described and it was shown that they conform to the conditions of development enunciated for those of Florida, Cuba, the Bahamas, the Virgin Islands, and the northern Leeward Islands, that is, all are superimposed on submerged platforms.

The principal barrier reefs of the Pacific Ocean were then considered, namely, the Great Barrier Reef of Australia, the barrier reefs of New Caledonia, and those of the Tahiti and Fiji groups. In each instance it was shown that the reefs occur on submerged platforms which are independent of the presence of the reefs and the conditions are therefore similar to those indicated for the Gulf of Mexico and Caribbean region of the Atlantic.

The remarks on the platforms of barrier coral reefs were summarized in the following words: ''This examination of the principal barrier coral reefs of the world leads to accordant results as regards the relations the reef platforms bear to change of sea level and the part played by corals and associated organisms as platform builders. All the platforms have been brought below sea level by a moderate submergence, less than forty-five fathoms, and the living reefs are superimposed on these platforms where the conditions necessary for their existence obtain.''

The history of many reef areas antecedent to the development of the recent reefs had been exceedingly complicated, and in much of the discussion of the problem, failure to recognize the proper sequence or the relative importance of events has led to misinterpretation. The consideration of these complexities is beyond the province of the paper.

The subject of atolls was briefly considered. The results of investigations recently conducted in Florida show that of the two rival hypotheses for the formation of atolls, whether by submarine solution or by constructional agencies, the formation by the former method, as relates to Florida, must be eliminated from consideration. This conclusion coincides with the results of Hedley and Griffith Taylor obtained on the Great Barrier Reef of Australia and those of Wood-Jones from a study of the Cocos-Keeling group. The results of the author's investigations of the effects of winds and currents in shaping atoll rims confirm the opinions already published by Hedley and Taylor and by Wood-Jones. The atoll rims of both the Marquesas and the Tortugas are constructional phenomena and owe their configuration to the prevailing winds and currents. The atolls along the line of the Great Barrier Reef of Australia and those of the Florida coral reef tract rise above a comparatively shallow platform. The atolls that encircle in various degrees the edges of the flat summits of mountains rising from oceanic depths must be attributed to somewhat different causes, although the effect of winds and currents in shaping such atolls must be admitted. The greater restriction of the reef-forming organisms to the outer margin of the flat summits is mostly if not solely due to the intolerance of reef-forming organisms to sediment.

It was then stated that Admiral Sir W. J. L. Wharton had clearly pointed out the incompleteness of atoll rims by his words "the low rim of growing coral which encircles their edges in various degrees." Daly's compilation of the depths of atoll lagoons is most significant, as it shows accordance in depth with the lagoon channels within barrier reefs. Great crustal subsidence for atoll areas is not indicated by the facts at present available; the evidence, however, does indicate a Recent increase in the depth of water in barrier reef and atoll areas by an amount of twenty fathoms or somewhat more but not so great as fifty fathoms.

The author did not attempt to explain the processes whereby the platforms on which the reefs stand are formed. He merely showed that they are older than the Recent reefs, that they have been brought into their present relation to sea level by submergence, and that the reefs are superimposed on them. The problem of the formation of these platforms, although one of great geologic importance, is aside from the immediate object of the paper.

Mr. J. E. Spurr has supplied the following note bearing upon the results of Mr. Vaughan's work:

"The following observations which were made on the stream mouths along the east coast of Nicaragua are presented, as bearing on the recent discussions of the relation of coral reefs to coastal submergence:

"The writer has recently visited repeatedly the east coast of Nicaragua from Cape Gracias á Dios to Bluefields, and has had occasion to observe a large part of the valley of two of the major streams which empty along this coast: the Wonks, or Wonki, or Coco River, and the Prinzapolca River. He also visited, several times, the lower portion of a third important river, the Escondido, which empties at Bluefields. The lower portions of all these streams have unmistakably, it seems to the writer, the usual characteristics of submerged river channels indicating relatively recent uniform and slight submergence of the coast line. This accords with the explanation deduced by Vaughan as to the locus of the coral reefs which occur in a belt adjacent to this coast,—an explanation which, I understand, has been arrived at by a study of similar areas and by deduction from conditions shown in existing charts."

OTHER ABSTRACTS *

Over the San Juan Mountains to the Mesa Verde. By Wallace W. Atwood. The dissection of a great volcanic plateau in the southwestern portion of Colorado has resulted in the development of a group of magnificent scenic features, the present San Juan Mountains. This work of land sculpture has continued through at least three cycles of erosion and has advanced into a fourth cycle. During that time there have been at least three epochs of mountain glaciation in the region. A record of a still earlier glacial period preceding the development of the great plateau has also been recently found at the northwest base of the range. In the plateau and mesa country bordering the mountains the record of erosion is remarkably well preserved and the surfaces of many of the mesas are mantled with débris washed from the mountains during the various cycles of erosion.

To the southwest of the range is Mesa Verde, where there is a remarkable group of ancient cliff dwellings. The life of the ancient cliff dwellers appears to have been largely controlled by the physiographic conditions which obtained in that region during the time that the dwellings were occupied.

In the Forest of Sunburst: A Study in Anthropogeography. By Collier Cobb. Seventy-six per cent. of western North Carolina is still under forest cover, or a little more than 3,000,000 acres of forest land is found in the sixteen mountain counties. The Forest of Sunburst lies in the densest portion of this forest area, occupying the slopes of Pisgah Range and the High Balsams and the valleys and coves included between them, thus covering the whole of the upper portion of the basin of Pigeon River and its tributaries. The mountains of North Carolina are the oldest forest land on the continent, and the botanists and plant geographers are agreed that the deciduous forests of eastern North America have been derived from that forest which reaches its greatest development in this mountainous region of western North Carolina.

While the hardwoods of the northern United States have migrated from the mountains since the last glacial period it seems equally certain that the coniferous growth on the Balsams and other high mountains was forced south at the time of the greatest extension of the ice sheet, and is able to survive now only in the cooler atmosphere of our high mountains.

The mean annual temperature in these mountains is 48°, and in the valleys they enclose, 54° Fahr.; while the rainfall of the region, most of which comes in the growing season, is 70 inches, being greater than that for any other portion of the United States except the Puget Sound Region.

This forest region was but sparsely inhabited a century and a half ago though a few bold men of the better class had moved from the lowlands into the mountains. None of the ''poor whites'' ventured across the Blue Ridge, and the term ''mountain whites'' applied to these highlanders, in distinction from the so-called ''poor whites,'' is wholly misleading since the mountaineers were never of this class.

The first frontiersmen in this forest region were from those Swiss and German Palatines who began flocking into Pennsylvania late in the seventeenth century. They settled originally "to the westward of the Quakers in the fertile limestone belts at the foot of the Blue Ridge and the Alleghanies. Here they formed the Quakers' buffer against the Indians, and, for some time, theirs were the westernmost settlements of British subjects in America. These Germans were of the Reformed or Lutheran faith. They were strongly democratic in a social sense, and detested slavery. They were model farmers and many of them were skilled workmen at trades."

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* These are shorter abstracts, supplied by the authors of papers read at the same meeting. Professor F. J. Turner's abstract of "Geographical Influences in American Political History," Mr. Oliver L. Fassig's abstract of "The Period of Safe Plant Growth in Maryland and Delaware," and Dr. L. A. Bauer's lecture on "The General Magnetic Survey of the Earth" will appear in the *Bulletin* later.

These were later followed by Scotch-Irish who came from Ulster County, Ireland, when their leases from James I. had expired, and they were persecuted and evicted. Froude tells us that, "In the two years that followed the Antrim evictions, 30,000 Protestants left Ulster for a land where there was no legal robbery, and where those who sowed the seed could reap the harvest."

These people settled on the frontier of the British colonies in America, all the way from central Massachusetts to the Valley of Virginia, being in Pennsylvania just beyond the German settlements. Immediately they began fighting Indians, and gradually extended their conquests down into the piedmont and mountain regions of the South. From Lancaster, York, and Berks County, Pa., came the ancestors of the men who have counted for most in this section, from Daniel Boone and David Crockett to John C. Calhoun and William A. Graham, to Zeb Vance and Peter C. Pritchard. The mountaineers are of this same blood to-day, with not one whit of admixture from any other source; and they have preserved in these forests the manners and customs of their Teutonic and Scottish ancestors, and their speech is the good idiomatic English of the Scottish borderland, with nothing approaching a dialect. They are merely our contemporary ancestors lacking our present-day outlook; and needing not missionaries, but economic opportunity. Their speech is in no sense Elizabethan, as some have reported, for I have heard in Pennsylvania within the last thirty years, every form of expression with which I am familiar in western North Carolina, and some of them occur to-day around Worcester, Mass.

The illustrations [lantern slides] show the people at their daily tasks in the Forest of Sunburst, where I have known them since 1872 and taught them in 1881-2-3, and have been with them a month or more every summer since that time. There has always been a marked absence of blood feuds among them. No people in the world are quicker to lay hold on opportunity; and what they can do for themselves in this and the adjoining Pisgah Forest is well shown by their advancements under improving conditions. The stimulus given to the arts and crafts of the mountains by the coming of the tourist to this region is showing itself in the revival and great extension of their ancient home industries; and some of the most skilled carvers came out of these forests.

Land Sculpturing Processes in Arid Lands, with Observations from Northeastern Africa. By William Herbert Hobbs. The introduction to this paper consisted of a review of the ideas which have been held by geologists to account for the origin of the great basin-like depressions of the arid lands, and the evolution of the doctrine of deflation with emphasis upon the work of Walther, Passarge and the geologists of the Egyptian Survey. The original contribution of the paper related to the origin of the basins which lie within the great Libyan hamada to the west of the Nile Valley, the so-called "oases" of the Libyan Desert. Briefly stated, the evidence that these depressions have originated largely through the process of deflation, consists in the general evenness and horizontality of the hamada, the local nature of the disturbances in association with the depressions, the fierce duststorms and sandstorms of the region, the essential uniformity in direction of the strong winds and the trains of dunes trailing off far to leeward of the depressions, the steep northern and the graded southern descents into the basins, and, lastly, the deep loess soils (cotton soils) of the Sudan to leeward of the depressions where the equatorial rains have caught and held the migrating dust. The peculiarly simple conditions which are encountered are further explained by the fact that the hard capping of limestone in the hamada is immediately underlain by soft shaly deposits, and this has given rise to the belief that the local displacements have fixed the position of existing depressions through permitting this protective cover to be locally attacked by the drifting sands and undermined. Evidence that the effective range of action of drifting sand extends but a few feet above the surface of the ground was presented both for the region especially treated and for other arid districts.

Botanical Phenomena and the Problem of Coastal Subsidence. By Douglas W. Johnson. Students of shoreline physiography must devote much attention to such botanical phenomena as furnish evidence of recent changes in the horizontal or vertical position of the coast. The kinds of plants and plant remains in the marshes, the distribution of plants on the beaches, and the physical condition of plants at the immediate shoreline give reliable indications of recent shoreline changes. Unfortunately, this botanical evidence has been widely misinterpreted to indicate a progressive subsidence of the land. The paper supports the thesis that the botanical phenomena prove horizontal and vertical fluctuations of the shoreline which are not connected with any general land movement.

The Characteristics of the Mississippi Delta in the Light of some Observations on Old World Deltas. By E. W. Shaw. Certain phenomena, particularly irregular subsidence on land and the upheavals off shore known as mud lumps, suggest that the Mississippi delta is affected by internal flowage. In the hope of obtaining important side light on this and other problems, a brief examination has recently been made of many large and small deltas of Europe, Northern Africa, and Western Asia. The progress made in understanding the Mississippi delta was, however, through the observation of dissimilar, rather than similar characters, for each delta seems to be built on individual specifications. The Mississippi delta appears to be unique in the rapidity of its growth, in the fineness and arrangement of the materials composing it, and in other characters which seem related to these, such as the extreme development of the bird foot form, the narrowness, depth, and stability of its stream channels, and, most interesting of all, a condition of unstable equilibrium.

The stability of a delta appears to depend principally on (1) its thickness, (2) the slope of its front, (3) the proportion of sand in the river's sediment, (4) the extent to which this sediment is washed by the sea or lake, (5) the rate of growth, and (6) the degree to which extremely fine watery sediment is separated into layers of wide extent. In the Mississippi delta all these factors seem to favor instability. The thickness is thousands of feet. The front, though not steeper than that of many sand deltas, is very steep for a mud delta, and might be steeper were it not for flowage. The river delivers to the sea relatively little sand, and most of that is brought at times of high water. The sea does not sort or carry away much of the sediment, so that the delta grows rapidly and layers of sandy silt corresponding to high stages of the river are separated by layers consisting of soft flocculated clay and other fine watery material.

The Tree as a Factor in Man's Adjustment to Hilly and Rocky Lands. By J. Russell Smith. Man's living depends upon plants, and plants upon the soil, requiring, in addition to fertility, heat, light, and moisture. American agriculture has added to these the fifth factor, tillage, which is artificial. By its topographic soil requirements, the plow becomes the limiting factor in production (other than the thin harvests supplied by forest and pasture) for a large proportion of our land that is fit in all respects for heavy plant growth. The tree crop growers of Majorca, Sicily and Corsica show us instructive methods of hill utilization whose results exceed the yields of wood producing forestry or pasture.

THE TOPOGRAPHIC MAP OF MEXICO

(Map facing p. 434.)

Mexico is one of the few Latin-American countries which is issuing a large-scale topographic map of its territory. The official title of the Mexican map is "Carta de la República Mexicana á la 100,000a" and, as the name implies, its scale is 1:100,000, or about 1.58 miles to the inch. The map is published by the Comisión Geográfico-Exploradora, which is under the joint jurisdiction of the Departments of Promotion (Fomento) and War. Two hundred sheets out of a proposed total of 1100 have been published so far (cf. footnote 3). These embrace mainly, as will be seen on the accompanying index map, the eastern part of the country (states of Nuevo Leon, Tamaulipas, San Luis Potosí, Vera Cruz, Puebla, Tlaxcala, part of Mexico, and the Distrito Federal) and certain sections in the north (central Sonora and northern Chihuahua).

The map is subdivided according to the rectangular system, *i. e.* each sheet is a rectangle whose sides do not coincide with parallels and meridians, the projection having been laid out for the whole map as a unit. The whole map is conceived to be divided into nine sheets on the scale of 1:2,000,000, numbered from 1 to 9 (heavy Arabic numerals in block lettering on the accompanying index map); each of these in turn into four sheets on the scale of 1:1,000,000, numbered consecutively from 1 to 24 in so far as they cover Mexican territory (smaller Arabic numerals in Roman lettering); each of these again into four sheets on the scale of 1:500,000, numbered from I to IV (Roman numerals); and, finally, each of these into twenty-five sheets on the scale of 1:100,000, designated by letter as shown on the diagram in the upper right hand corner of the index map. Except for those on the scale of 1:100,000, no sheets have been published, as such, of any of these series, as far as it has been possible to ascertain, although the scales of 1:500,000 and 1:2,000,000 are represented in other official maps, as referred to below. The published sheets on the scale of 1:100,000 are designated according to their position within the two next higher units of subdivision. Thus, the sheets containing Tampico and Vera Cruz are designated respectively 14–I–(Z) and 19–II–(S).